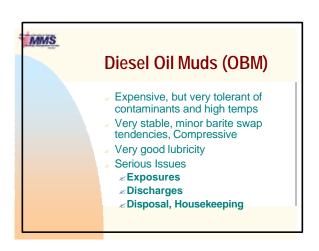
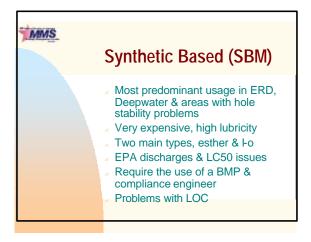
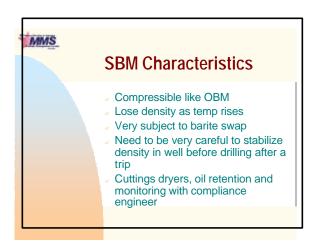


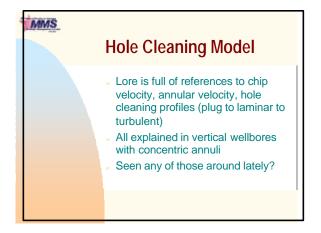
Water-Based Systems Benefit the most from lubricants Combinations of surfactants, mineral oil, snake oil Most successfully used in fit-forpurpose approaches, MLD Milne Point cocktail, ANS Highest Friction Factors of any system with the lowest \$/bbl cost Drill-In Systems (Flo-Pro)



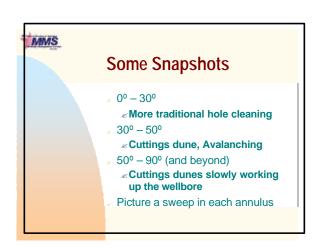




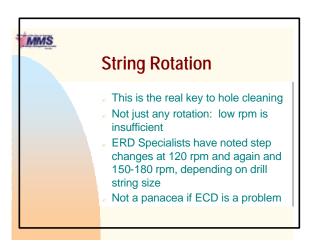
Hole Cleaning Hole Sweeps Hole Angles <30° Improve as well goes vertical Very low benefit >30° Mainly contaminate mud system and drive up rheologies, causing other wellbore problems Satisfy the Office (or Field)



Pirectional Wells, Eccentric Annuli Varying hole angles and turns ECD problems lead to controlled ROPs, minimum rheologies Cuttings fall to bottom of wellbore around drill string, particularly in angle building sections when there's a high proportion of sliding vs. rotary drilling



How Does Hole get Cleaned? The real answer is that many times it doesn't, resulting in stuck pipe, wasted time on trips, lost wells Drillers are Optimists ERD: Exactly Reverse Direction Assume hole is NOT clean until it proves otherwise Torque, Drag, Circ Press, Cuttings



Holes with extended 70° and above tangent sections rarely even begin to clean up until 2 bottoms up are observed Dunes are moving up the well and the hole will unload suddenly 4 bottoms up is typical, it can be more Torque/Drag analysis: condition

Drilling while Cleaning It's not impossible, but the mechanisms need to be understood as they apply to a given wellbore geometry Great advantage of rotary drilling vs. motor drilling is hole cleaning (plus the lower tortuosity and micro-doglegs from tool sets) Weighing cuttings

Summary Points Mud systems fit for purpose Understand Hole Cleaning mechanism through a given well Dubious value (& wasted money and time) of sweep combinations Designing the well to be cleaned Drilling Clean (Motor Housings) Tripping Clean (Hole Cleaning) Casing Clean (Back Reaming)